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Losing a dime with a satisfied mind:

Positive affect predicts less search in sequential decision making

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RUNNING HEAD: Age, Affect and Sequential Decision Making

Abstract

We investigated the contribution of cognitive ability and affect to age differences in sequential decision making by asking younger and older adults to shop for items in a computerized sequential decision-making task. Older adults performed poorly compared to younger adults partly due to searching too few options. An analysis of the decision process with a formal model suggested that older adults set lower thresholds for accepting an option than younger participants. Further analyses suggested that positive affect, but not fluid abilities, was related to search in the sequential decision task. A second study that manipulated affect in younger adults supported the causal role of affect: Increased positive affect lowered the initial threshold for accepting an attractive option. In sum, our results suggest that positive affect is a key factor determining search in sequential decision making. Consequently, increased positive affect in older age may contribute to poorer sequential decisions by leading to insufficient search.

Keywords: Decision Making; Sequential Choice; Aging; Satisfaction; Positive Affect;

Word count:

„Suddenly it happened, I lost every dime

But I'm richer by far with a satisfied mind“

(J. H. Hayes/Jack Rhodes)

From finding mates to apartments, many decisions people face are sequential. Sequential decisions are often difficult because one is forced to evaluate options on the spot and does not have the luxury to change his mind: A partner will likely move on if you court others, or a landlord will pick the next interested tenant if you hesitate to take an apartment. The trick lies in neither stopping search too early nor too late so as not to miss out on the best partner or apartment. One token of this class of problems is the well-known secretary problem in which decision makers must select the best job candidate out of a sequentially presented pool of applicants without any prior knowledge about the distribution of the applicants' quality (Fergusson, 1989; Gilbert & Mosteller, 1966). The options are presented in a random order and an option that has been rejected cannot be recalled at a later time. The optimal solution to this problem can be described by a simple threshold strategy (Ferguson, 1989). According to the threshold strategy, the decision-maker searches through a number of options to gain experience about the possible candidates' quality. After enough experience has been gained, a threshold is set equivalent to the best option seen thus far and the next option that exceeds the threshold is chosen. The threshold strategy describes well how individuals solve the secretary problem, although people tend to have lower thresholds and thus search less than the optimal strategy would prescribe (Bearden, Rapoport & Murphy, 2006; Seale & Rapoport, 1997; 2000; von Helversen, Wilke, Johnson, Schmid, Klapp, 2011; but see Zwick, Rapoport, Lo, & Muthukrishnan, 2003). But do younger and older adults differ in their sequential decision making?

Aging is associated with decline in cognitive abilities potentially relevant for decision-making. Older adults seem to perform worse in a number of decision tasks due to cognitive limitations (Bruine de Bruin, Parker, & Fischoff, 2010; Finucane & Gullion, 2010; Mata, von Helversen, Karlsson, & Cüpper, 2011; Mata, von Helversen & Rieskamp, 2010; Mata, Schooler, & Rieskamp, 2007). At the same time, aging is associated with affective and motivational changes found to affect decision making by influencing pre-decisional information search (Löckenhoff & Carstensen, 2007), post-choice memory (Mather, Knight, & McCaffrey, 2005), and choice satisfaction (Kim, Healey, Goldstein, Hasher, & Wiprzycka, 2008). In this paper, we investigate whether age related changes in both cognitive capacities and affect impact decisions in a sequential decision making task.

Cognitive limitations may be one source of differences between younger and older adults' sequential decisions. Burns, Lee, and Vickers (2006) showed that performance in the secretary problem was correlated with fluid cognitive abilities, such as processing speed. Aging has been connected to decreases in such fluid abilities (Salthouse, 1996) and limitations in fluid abilities may underlie age differences in pre-decisional information search (Mata & Nunes, 2010). For example, Mata, et al., (2007) found that older adults searched about 15% less information before making a decision compared to younger adults and that individual differences in fluid abilities could account for age-related differences in search in a multi-attribute decision task. In sum, to the extent that sequential decisions tax individuals' cognitive abilities there is potential for age differences in these decision tasks.

Affective experience is another likely source of differences between younger and older adults' sequential decisions. Aging is associated with higher emotional competence (Blanchard-Fields, 2007; John & Gross, 2004; Phillips, Henry, Hosie, & Milne, 2008; Scheibe & Blanchard-Fields, 2009) and improved affective experience (Carstensen, 2006; Carstensen, et al., 2011; Charles, Reynolds, & Gatz, 2001; Röcke, Li, & Smith, 2009). Affect may influence peoples' decision making by affecting people's search tendencies: Increased positive affect has been connected to less information search in judgments (Fiedler, Renn & Kareev, 2009), consumer decisions (Beatty & Ferrell, 1998), multi-attribute decision tasks

(Isen & Means, 1983), and sequential decision tasks (von Helversen, et al., 2011). Positive affect may reduce search by generally promoting superficial thinking (see Bless & Fiedler, 2006; Schwarz & Clore, 2006). In addition, people in a positive mood tend to evaluate attractive objects even more positively (e.g. Adaval, 2003; Bower, 1991; Howard & Barry, 1994), which in a sequential decision making task could translate into terminating search early by accepting an object that would otherwise be rejected.

In sum, past work suggests that systematic age differences in both affect and cognitive abilities may lead to older adults searching less relative to younger adults prior to making a decision and may, ultimately, impact decision quality in sequential decision making. The present study aims to test these scenarios by asking younger and older adults to make decisions in a sequential decision making task.

STUDY 1

We asked younger and older adults to perform a sequential decision making task in the form of a computerized shopping task. Participants were asked to shop for 60 different consumer products (e.g., LCD monitors, lawn mowers, refrigerators) with the goal of finding the lowest priced offer. For each product (e.g. LCD monitor), participants could see up to 40 offers varying only in price. They had to decide when to stop search and accept the current offer. Participants were also regularly asked to indicate their performance goals as well as their satisfaction with their performance. Thus, the shopping task uses an everyday scenario to assess how younger and older adults differ in search behavior, goals, and choice satisfaction, as well as whether these translate into differential decision quality.

Our expectation was that older adults would search fewer options (Mata & Nunes, 2010), and be equally or potentially more satisfied with their choices relative to younger adults (Kim et al., 2008). We also asked participants to complete affect and cognitive ability measures because we aimed to test the hypotheses that positive affect and/or cognitive limitations are linked to search in sequential choice. We thus hoped to understand the contribution of affect and cognitive abilities to age differences in sequential decision making.

Method

Participants

Sixty-four people, 32 younger adults (18 females, mean Age = 24.2, *SD* = 2.7) and 32 older adults (17 females; mean Age = 69.0, *SD* = 3.5) participated in the study. Younger adults were students from one of the Berlin Universities (mean Years of Education = 15.6, *SD* = 4.6). Older adults were community-dwelling adults (mean Years of Education = 15.3, *SD* = 2.9), recruited from the participant database of the Max Planck Institute for Human Development, Berlin Germany. Participation took between 1 and 2 hours and participants received on average € 18 for their participation. The study was approved by the ethics committee of the Max Planck Institute for Human Development.

Affect and Cognitive Measures

Mean values for affect and cognitive measures are provided in Table 1. Affect was measured with the German version (Krohne, Egloff, Kohlmann & Tausch, 1996) of the Positive and Negative Affect Schedule (PANAS, Watson, Clark & Tellegen, 1988), consisting of 10 positive and 10 negative affective words, such as excited or distressed. Participants rated how well each item described their current mood on a scale from 1 (not at all) to 7 (very much). Positive and negative affect scores were calculated by taking the mean rating of the positive and negative items respectively. Reliability was adequate for both scales and both measurement occasions (all Cronbachs' $\alpha > .88$). Participants also completed a number of cognitive tasks, namely, a vocabulary test (Lehrl, 1999), a processing speed task (digit-symbol substitution; Wechsler, 1981), and the cognitive reflection test (CRT; Frederick, 2005). The cognitive reflection test is a 3-item measure (e.g. "a bat and a ball cost $1.10 in total; the bat costs $1.00 more than the ball; how much does the ball cost?“) and is thought to measure one’s ability to engage in effortful inference processes and avoid judgment biases (Frederick, 2005; Oechssler, Roider, & Schmitz, 2009).

Shopping Task Problems

The participants’ task was to purchase consumer products (e.g., LCD monitors, lawn mowers, refrigerators) for the lowest price possible. The prices for the different consumer products shown to participants were realistic so as to maximize the likelihood that older adults would remember these (Castel, 2005). For this purpose, we searched for the lowest and the highest price for each product on internet websites and then generated prices by drawing values from a normal distribution with a mean equal to the average value of the highest and lowest prices and a standard deviation set so that 98% of the prices would fall between the highest and the lowest price.

Procedure

Participants first completed the affect measure. Participants then read the instructions for the shopping task and completed a practice trial. For the practice trial and each of the following 60 consumer products (e.g., LCD monitor) participants could search through 40 price offers that were presented sequentially in a random order. At each step an offer was presented and participants could choose to accept or reject the offer at their own pace. Additionally, participants were informed about the number of remaining offers for a specific product (see Figure 1 for a screen shot). If the offer was rejected, it expired and participants were presented with the next offer. An expired offer could not be chosen at a later point of time. If participants had not accepted an offer for a product (e.g. LCD monitor) before they had seen all 40 offers they were forced to accept the last offer. If an offer was accepted, the product (e.g., LCD monitor) was bought for the offered price and participants received explicit feedback about its rank and the points earned. Then participants moved on to the next product (e.g., lawn mower). Participants were paid according to the rank of the selected offer. Rank refers to the relative price of the selected offer compared to the 40 offers for that product, that is the cheapest offer has a rank of 1, the second cheapest a rank of 2, and so on. Participants received 40 points for the best offer (i.e. rank 1), 39 for the second best offer (rank 2), and so on. At the end of the experiment points were converted to Euro at a rate of 100 points = .5 Euro.

The 60 products were aggregated in 12 blocks consisting of 5 products each. In each of the 12 blocks, participants were first asked to indicate their performance goals by indicating the *Desired Rank* of the offers that they aspired to reach. Specifically, they had to indicate how high (i.e. from 1 to 40) the offers they selected should be ranked to satisfy them with their performance. They then completed the five games corresponding to 5 different consumer products, and finally indicated their *Satisfaction* with their performance on a 5-point scale (1 = not satisfied at all, 5 = very satisfied). After completing the shopping task, participants again completed the affect measure, the measures of cognitive ability, and a number of questionnaires that are not the focus of this paper.[1] The data on measures of cognitive abilities for four participants (two younger and two older) were lost.

Results

Performance and Search

Performance and search are key behavioral measures in the sequential choice task. Performance was measured as the average rank of the options participants selected across the 60 problems encountered. Search was measured as the average number of options considered before making a choice. Mean values for younger and older adults are presented in Table 1. Descriptive analyses for each age group indicated two outliers that performed three standard deviations below their peers and which we excluded from further analyses[2]: One younger adult selected options with an average rank of 11 compared to an average rank of 5 for younger adults, and one older adult chose options with an average rank of 22 compared to an average rank of 7 for older adults. These numbers also indicate that older adults performed substantially worse than younger adults: On average, older adults selected offers 2 ranks below those selected by younger adults (see Table 1 for statistical tests). To better gauge participants' performance we considered three reference points: an optimal strategy, a multiple threshold strategy, and a random strategy. The optimal strategy possesses knowledge about the quality distribution of the offers and uses a decreasing threshold based on the expected value that is updated at each decision step. The optimal strategy would allow selecting the 2nd best option out of 40 on average. A decision maker without distribution knowledge could rely on a multiple threshold strategy that approximates optimal performance in this task (Bearden, et al., 2006; von Helversen, et al., 2011), and select the 4th best option out of 40 on average. In turn, random choice would lead to selecting the 20th best option out of 40 on average. When contrasting participants' performance to these benchmarks one can conclude that while both age groups performed on average worse than an optimal strategy, both younger and older adults did clearly better than chance. In sum, the multiple threshold strategy matches most closely participants' average performance. In the following section we provide evidence that such a strategy indeed captures participants choices well.

Next, we compared the average numbers of objects searched by younger and older adults. We found that older adults searched overall fewer offers compared to younger adults (see Table 1 for statistical tests). In the secretary problem one would expect that search length has a quadratic relationship to performance – searching too little as well as too much can lead to suboptimal performance. As illustrated in Figure 2 (left panel), we found in an analysis including both age groups that search had a quadratic relation to performance, explaining 57% of the variance in performance, $F(2,59) = 38.32$, $p = .001$. Separate analyses for older and younger adults showed similar results, with search explaining 35% of the variance in performance in younger adults, $F(2,28) = 7.48$, $p < .01$, and 55% of the variance in performance in older adults, $F(2,28) = 17.16$, $p < .01$.

Modeling Behavior in the Secretary Problem

To better understand how younger and older participants solved the sequential choice task we computationally modeled their choices with a multiple threshold strategy. The multiple threshold model has been successfully applied to sequential decision making tasks with rank dependent payoffs (Bearden, et al., 2006; von Helversen & Johnson, 2008; von Helversen et al., 2011). The model has several parameters that can be interpreted as capturing internal thresholds for accepting an offer that is best, second best, and so on, in comparison with previously seen offers. For example, if the first threshold is twelve, the participant would not accept any of the first eleven offers, but would accept, from offer twelve onward, the next offer that was better than any of the previous offers. In the same vein, the second threshold captures from when on in the search, a participant would accept an offer that is only the second-best of the offers he or she has seen thus far. We assumed that participants' choices are in line with a multiple threshold strategy, but that the parameter values of the thresholds can differ between participants. To find the threshold values which best explained the participants' choices, we estimated the best fitting threshold parameter values to the data of individual participants choosing the threshold values that maximized the number of choices predicted by the model. Additionally we implemented an error parameter to capture choices that deviated from model predictions because the participant rejected the first option that was predicted by the model. This error parameter may capture unintentional rejections for instance because a participant clicked too fast through the options. Alternatively, the error parameter can be interpreted as variance in choice, implying that thresholds are not deterministic but probabilistic in nature.

A model relying on three threshold parameters captured participants' choices well, explaining 68% of all choices (for more details on the multiple threshold model and model fitting see Appendix A). In comparison, a baseline model using a single parameter that predicts that the same number of options is searched in all trials could explain only 12 % of participants' choices. Older and younger adults were equally well described suggesting that the model can capture the decisions of both age groups equivalently. As can be seen in Table 1, in accordance with the behavioral results on search, older adults had lower thresholds than younger adults, suggesting that older adults searched less than younger adults because they had lower thresholds for accepting an option.

Affect, Cognitive Ability, and Sequential Decision Making

Can differences in affect or cognitive ability account for why older adults searched fewer options and had less stringent thresholds relative to younger adults? Affect was measured before and after the task. Older adults reported higher positive but similar negative affect relative to younger adults at both time points (see Röcke et al., 2009, for a similar result). Concerning the cognitive measures, older adults performed worse on the processing speed task, similarly on the cognitive reflection task, and better in the vocabulary task relative to younger adults (see Table 1 for statistical tests).

We relied on correlation analyses to investigate the link between both affect and cognitive abilities and sequential decision-making. Regarding affect, we focused on the first measurement, as affect after the task could be influenced by task performance. As can be seen in Table 2, higher positive affect was related to worse performance, less search, and lower threshold parameters. To investigate how specific emotional states related to sequential choice behavior we additionally analyzed correlations between the decision variables and individual affect items. Overall, search and performance were related to the majority of affect items but the item *enthusiastic* correlated highest with both search, $r(62) = -.36$, $p < .01$, and threshold

1, $r(62) = -.38$, $p < .01$. Complete reports of the item level correlations can be found in Appendix B, Table B1. Negative affect was not related to performance or search. Regarding the cognitive measures, processing speed was negatively related to performance, but none of the cognitive measures was significantly related to search length or thresholds. The results were supported by an additional regression analysis on search with positive and negative affect and cognitive abilities as predictors. Only positive affect emerged as a significant predictor, $b = -.38$, $t(52) = 2.56$, $p = .01$; including age group in the regression reduced the impact of positive affect somewhat, $b = -.32$, $t(51) = 1.92$, $p = .06$. The effect of age group was no longer significant, $b_{age} = -.16$, $t(51) = -.78$, $p = .44$. In sum, the results seem to suggest that individual differences in positive affect but not fluid cognitive abilities were related to search in the sequential decision task. To find out if the relation would hold for both younger and older adults, we also conducted similar analyses within each age group (see Table 3): We found no relation between cognitive or affect measures and sequential decision making in the younger sample. In contrast, in older adults, positive affect showed a strong relation to search (see Figure 2, right panel), and similar albeit weaker correlations with threshold parameters. In sum, our results suggest that positive affect, but not cognitive ability, is related to reduced search in older adults.

Affect, Performance Goals, and Choice Satisfaction

Older adults performed worse and reported higher performance goals relative to younger adults, yet they showed similar levels of satisfaction with their choices to those of younger participants (see Table 1). These findings raise the possibility that older adults' choice satisfaction may not be simply a function of objective decision performance but may depend on other factors such as positive affect. Across all participants, performance was related to choice satisfaction, in the direction that higher satisfaction was related to better performance, $r\ (62) = -.27$, $p = .03$. Overall, positive affect did not correlate with satisfaction, *r* (62) = .08, *p* = .55. However, when we analyzed whether positive affect was correlated with choice satisfaction separately for the two age groups we found a marginal correlation for older adults: *r* (31) = .32, *p* = .08, albeit not for younger adults: *r*(31) = .05, *p* = .76. This result was supported by an additional multi-level analysis taking advantage of the repeated measures of satisfaction and performance. The analysis showed that whereas satisfaction was related to performance for older and younger adults, positive affect was only related to satisfaction for older adults (for details on the analysis see Appendix C). Overall, these findings suggest that positive affect, at least in older adults, can influence subjective aspects of decision making, such as choice satisfaction.

Discussion of Study 1

We investigated how younger and older adults solved a sequential decision making task. Overall, older adults considered fewer options and choose worse options than younger adults. For both younger and older adults search was closely related to performance, suggesting that searching less may have contributed to age differences in decision performance. We also modeled participants' decision processes with a formal model that assumes that decision makers use multiple thresholds to decide when to buy an option. The model provided a good fit to younger and older adults' choices and estimates for the threshold parameters corroborated the behavioral results on search: Older adults had significantly lower values on threshold parameters relative to younger adults, suggesting that older adults were willing to accept options earlier in the search process. These findings parallel others suggesting that older adults prefer having fewer options to choose from (Reed, Mikels, & Simon, 2008), tend to make immediate decisions (Meyer, Talbot & Ranalli, 2007) and search less information prior to making a decision in multi-attribute decision tasks (Mata & Nunes, 2010).

We also aimed to assess the contribution of affect and cognitive abilities to age differences in search behavior in sequential decision making. Correlation analyses suggested that positive affect but not cognitive abilities, such as speed of processing, were related to search in the sequential decision task. The result supports the notion that increased positive affect can influence peoples' decision making by inducing people to search less either through promoting superficial thinking (e.g. Bless & Fiedler, 2006; Schwarz & Clore, 2006) or overly positive evaluations of options (e.g. Adaval, 2003; Bower, 1991; Howard & Barry, 1994). A closer look at the data revealed, however, that positive affect was related to search in older but not younger adults.

There are two possible explanations for our finding of a link between positive affect and decision making in older but not younger adults. First, the relation between positive affect and lower thresholds for accepting an option is specific to older adults in line with claims that older adults rely more on affect when making decisions than younger adults (e.g., Hanoch, Wood, & Rice, 2007). Second, higher levels of positive affect decrease thresholds for accepting an option in both younger and older adults, but in our study younger adults' naturally occurring individual differences in affect were not sufficient to impact decision behavior. The second explanation implies that younger adults should behave more like older adults, and thus tend to accept options earlier whenever they experience higher levels of positive affect. We conducted a second study in which we manipulated positive affect in younger adults to test whether higher levels of positive affect lead to accepting an option earlier in sequential decisions.

STUDY 2

We manipulated mood in younger adults to investigate if elevated positive affect would lead to choice behavior similar to that of older adults in the sequential choice task. The study had two conditions: a positive affect condition and a neutral affect condition.

Method

Participants

Eighty-one students from the University of Basel participated in study 2 (40 in the neutral and 41 in the positive condition; M_{age} = 23.42, *SD* = 6.11; 86% females). Participants received course credit or a show up fee and earned between 3 and 7 CHF additionally depending on their performance in the task.

Design and Procedure

Participants completed the same sequential choice task as described in study 1. Affect was manipulated prior to completing the sequential decision making task. The affect manipulation consisted of showing participants fifteen pictures from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2008) for 7 sec each prior to the decision task (for similar mood manipulations see Dreisbach & Goschke, 2004; Piñon & Gärling, 2004). Additionally, we showed participants 4 pictures after every 5 trials of the decision task. The pictures were selected based on the ratings of valence and arousal. In the positive condition participants saw pictures that had received highly positive ratings. In the neutral condition participants saw pictures that had received average ratings. Arousal was kept constant between the conditions. Because ratings of valence and arousal differ by gender (Fessler, Pillsworth, & Flamson, 2004; Lang, et al., 2008), we selected different sets of pictures for men and women to equate the impact of the pictures. The average ratings of valence and arousal for the selected pictures by condition and gender are reported in Table 4. Affect was measured with the PANAS (Krohne et al., 1996; Watson et al. 1988) at three time points: before the affect manipulation (time point 1), after the affect manipulation and before the sequential choice task (time point 2), and after the sequential choice task (time point 3).

Results

Manipulation of Affect

Participants showed similar levels of initial positive affect in both conditions, $t(79) = 0.49$, $p = .63$, $d = 0.10$ (for means and *SD*s see Table 5). After the affect manipulation positive affect increased in the positive condition, but was stable in the neutral condition, resulting in higher positive affect in the positive than in the neutral condition, $t(79) = 2.28$, $p = .02$, $d = 0.50$. During the task positive affect decreased in both conditions. At time point 3 participants in the positive condition reported marginally larger levels of positive affect than the neutral condition, $t(79) = 1.83$, $p = .07$, $d = 0.41$. Negative affect differed between conditions with participants in the positive condition reporting lower levels of negative affect than participants in the neutral condition at time point 1, $t(79) = 2.71$, $p = .01$, $d = 0.60$, and time point 2, $t(79) = 3.02$, $p = .003$, $d = 0.66$, but not at time point 3, $t(79) = 1.47$, $p = .15$, $d = 0.30$. Overall, these results suggest that the manipulation of affect was successful in that it increased positive affect differences between the two groups. In addition, the two groups also differed initially in negative affect by chance (participants were allocated randomly to the two conditions) and this difference remained significant after the positive mood induction. Consequently, the two groups differed in both positive and negative affect, which made it possible for us to investigate the role of both on sequential decision making.

Affect and Sequential Choices

To describe behavior in the sequential choice task, we again measured performance as the average rank of the selected options and search as the average number of offers considered. As in study 1 we also modeled participants' behavior with the multiple threshold model. The model described participants' choice well, explaining 70% of their choices *SD* = 9.71 (see Table 6 for means and standard deviations).

To analyze whether the affect manipulation influenced behavior in the sequential choice task, we compared participants' behavior in the neutral and the positive conditions. We did not find differences between the conditions for search or performance (for statistical tests see Table 6). However, participants in the positive condition had significantly lower values on the first threshold parameter than participants in the neutral condition, $t(79) = 2.33$, $p = .02$.

We conducted correlation analyses to investigate the role of positive and negative affect on threshold parameters estimated from the computational model of sequential decision making. Positive affect immediately after the mood manipulation was negatively correlated with the first threshold parameter, $r\ (81) = -.21$, $p = .055$. This correlation was of similar magnitude when controlling for negative affect at the first two time points, partial $r(77) = -.21$, $p = .067$, suggesting that the effect is independent of negative affect. Analyses conducted on individual affect items revealed that the first threshold was specifically correlated to items measuring positive valence, such as *excited*, $r(81) = -.26$, $p = .02$, and *enthusiastic*, $r(81) = -.29$, $p < .01$, but not to items measuring attentiveness, such as *alert*, $r(81) = -.06$, $p = .58$, or *attentive*, $r(81) = .003$, $p = .98$. For the complete item level correlations please see Appendix B, Table B2.

Regarding negative affect, we found a negative correlation between negative affect immediately after the mood manipulation and the second threshold parameter suggesting that higher negative affect led to lower thresholds for second-best offers, $r\ (81) = -.25$, $p = 02$. This correlation was of similar magnitude when controlling for positive affect at the first two time points, partial $r\ (77) = -.25$, $p = .03$, suggesting that the effect is independent of positive affect. An analysis on the item level showed that this correlation was driven by the items *upset*, r(81) = -.31, $p <.01$, *nervous*: $r(81) = -.23$, $p = .04$, and *jittery*: $r\ (81) = -.26$, $p =.02$.

Finally, participants in the positive and the neutral condition did not differ in their performance goals or reported satisfaction (see Table 6). Neither performance goals nor satisfaction correlated with positive or negative affect (all *p*s > .27). Satisfaction was also not correlated with search or performance in the sequential choice task.

Discussion of Study 2

We conducted an affect manipulation that increased younger adults' positive affect in a positive relative to a neutral condition. Although participants in the two conditions did not differ significantly in overall search length or performance, the first threshold for accepting an offer estimated from computational modeling was, as expected, lower in the positive relative to the neutral condition. The results suggest that high positive affect may increase the likelihood of accepting an attractive offer and thus that affect can impact younger adults' sequential decision making.

Analyses of affect at the item level suggested that the link between acceptance thresholds and positive affect was particularly strong for items measuring positive valence, as opposed to attentiveness. According to Watson and Clark (1994) positive affect encompasses more specific emotional states such as joviality, self-assurance and attentiveness: Joviality consists of items focused on the valence of the affective state, while attentiveness captures alertness or energy. These results suggest that an overall positive affect score such as that used in the PANAS may be too general to capture the effects of positive valence on sequential decision making in younger adults.

Our results also indicate that negative affect was related to thresholds for accepting options. Higher negative affect and specifically higher ratings of being upset, nervous and jittery were related to accepting second best options early. The role of negative affect on search and thresholds is not straightforward. Negative affect is comprised of specific emotional states such as fear, anger or sadness (Watson and Clark, 1994) and these emotional states have been shown to have opposing influences on decision behavior. Whereas sadness and fear have been associated with elaborate processing and increased search (Bless &

Fiedler, 2006; French, Hevey, Sutton, Kinmonth, & Marteau, 2006; Lerner, Gonzalez, Small, & Fischhoff, 2003; von Helversen et al. 2011), anger is usually associated with reduced information processing (Lerner et al. 2003; Lerner & Keltner, 2001; Fessler, et al., 2004). Thus, although our findings suggest that negative affect may lower thresholds in sequential decision making these results should be interpreted cautiously as we did not manipulate specific negative emotions. Gender effects may further complicate the pattern of effects regarding negative emotions: Men and women differ in how emotions such as anger or disgust influence their decisions (e.g. Fessler, et al., 2004). We did not find evidence that men and women were differentially influenced by the mood induction or differed significantly in their search behavior in study 2. However, gender effects may have been masked by the skewed gender ratio in our sample and so it would be important to examine the role of negative emotions in a more gender-balanced sample.

In sum, the second study showed that a manipulation leading to increased positive affect can lead to lower thresholds to accept an attractive option in a sample of younger adults. Consequently, the combined results of study 1 and 2 support the idea that affect can have an impact on sequential search in both older and younger adults.

General Discussion

We investigated how cognitive abilities and affect influence older and younger adults' sequential decision making. In study 1, we found that older adults performed worse than younger adults possibly due to reduced search. In addition, our results suggest that positive affect, but not fluid abilities, contributed to older adults searching less than younger adults: Older adults reported overall higher levels of positive affect and older adults' positive affect was related to search length and lower acceptance thresholds. Study 1 did not find a relation between younger adults' positive affect and any of the decision variables, raising the possibility that the link between affect and decision making is unique to the older group.

Study 2 manipulated affect in a sample of younger adults to test whether affect can affect sequential decision processes in younger adults and the results showed that higher levels of positive affect lowered acceptance thresholds. Taken together, this suggests that affect plays an important role in sequential choice regardless of age group but that naturally occurring differences in affect between younger and older adults may contribute to age differences in sequential decision making.

Affect and Search

We found that positive affect was related to acceptance thresholds in older adults (Study 1) and younger adults (Study 2). One explanation for this result is that positive affect leads to more superficial processing (e.g. Bless & Fiedler, 2006; Schwarz & Clore, 2006). Alternatively, high levels of positive affect may increase the perceived attractiveness of options thus increasing the likelihood that one is selected early on (e.g. Adaval, 2003; Bower, 1991; Howard & Barry, 1994).

Our results are suggestive of links between affect and search in sequential decision tasks but raise at least two outstanding issues regarding this link. First, our results suggest that more theorizing must be done regarding the role of different facets of positive emotion in younger and older adults. For example, our results suggest that there may be effects of valence but not attentiveness on search in younger adults (Study 2), but we observed a link between all positive affect items and search in older adults (Study 1). Second, the results from the two studies are at odds regarding the role of negative affect: While we found no effects of negative affect in Study 1, there were effects of negative affect on the second threshold parameter in Study 2. Because we relied on natural variation in affect in Study 1 and did not manipulate specific positive or negative emotions in Study 2 we cannot draw strong inferences from our results. Future work that considers more specific affect manipulations could prove useful in disentangling the role of different affect dimensions and specific emotions on search in sequential choice.

Affect and Satisfaction

Older and younger participants differed markedly in performance, yet we did not find differences between older and younger adults' choice satisfaction. This result is particularly striking given that older adults had more ambitious performance goals than their younger counterparts. The effects may be partly explained by the high levels of positive affect reported by older adults, which were related to high levels of satisfaction and possibly protected older adults from experiencing dissatisfaction after not reaching their performance goals. Kim et al., (2008) found older adults reported improved choice satisfaction relative to younger adults if given the opportunity to justify their choices. One potentially interesting line of research would be to assess whether justification processes underlie the resilience of older adults' choice satisfaction in the face of unmet goals and negative performance feedback.

Tolerable choice satisfaction in the face of poor performance can be problematic if it prevents older adults from improving their performance even when provided with negative performance feedback, as was the case in our task. Future work should aim to test manipulations that can improve older adults' decision in this context, for example, by providing relative feedback regarding the savings of other, perhaps younger participants.

Limitations and Future Directions

Decline in cognitive abilities has been suggested as the principal factor underlying age-related differences in performance in decision-making tasks impairing the ability to seek and evaluate information necessary for making a decision (Finucane, Mertz, Slovic & Scholze Schmidt, 2005; Mata et al., 2007; Mata et al., 2010; Henninger, Madden, & Huettel, 2010; Sharit, Hernandez, Czaja & Pirolli, 2008). Thus one would expect performance in sequential decision making to be related to cognitive abilities (Burns et al., 2006). In contrast, we found only a small relation between processing speed and performance, and no relation between cognitive abilities and overall search or acceptance thresholds. One possible reason for this null finding is that search in our sequential task was not sufficiently taxing on participants' cognitive abilities. Alternatively, our measures may have not been sensitive enough to capture age differences in the relevant cognitive abilities. For example, we did not measure working memory capacity, which has been identified as a key factor contributing to age differences in decision tasks (e.g. Mata et al., 2007) and correlates substantially with fluid abilities that have been found to predict performance in the secretary problem (Burns et al., 2006; Kane & Engle, 2002). Future research should expand the measures of cognitive abilities to allow quantifying their contribution to age differences in performance in sequential choice.

We compared older and younger adults' behavior in a laboratory task that was modeled on internet shopping where options are frequently evaluated sequentially. Older adults are less familiar with using internet sites and thus lack of familiarity with such a setting could have contributed to age differences in performance (Sharit et al., 2008; Sharit, Hernandez, Nair, Kuhn, & Czaja, 2011). In addition, although we selected a broad range of products and matched prices to actual offers on the internet, older and younger adults could have differed in their knowledge of product prices, which in turn may have influenced their willingness to accept an offer. Future work should control for experience with sequential choice tasks and knowledge of price distributions to assess the role of past experience to age differences in sequential decision making.

Our results may have implications for real world decision making. We found that older adults performed substantially worse than younger adults in a laboratory decision making task and to the extent that our task mimics natural settings one could expect older adults to show decreased decision quality in real-world choices involving sequential evaluation of options. Nevertheless, there are reasons to believe that reduced search may not always lead to poor decision outcomes. For example, Mata and Nunes (2011) found that using less information has a negligible effect on decision quality in consumer decisions in which options were presented simultaneously. Likewise, some conditions may foster competent decisions in the face of limited search in sequential decisions, for example, limited search may have negligible effects when options differ little in quality and/or are presented in decreasing order of quality. Consequently, a description of the real-world environments faced by younger and older adults is crucial to understand to what extent age differences in search lead to poorer decision outcomes.

Conclusion

Positive affect is generally considered a good thing. Increased positive affect has been linked to health and longevity (Pressman & Cohen, 2005), success (Lyubomirsky, King & Diener, 2005), and enhanced creativity and problem solving (Estrada, Isen & Young, 1997; Isen & Labroo, 2003). However, positive affect has a darker side when it leads to superficial or stereotypical thinking (Bless & Fiedler, 2006; Schwarz & Clore, 2006). Our results suggest that high levels of positive affect as reported by the elderly can lead to insufficient search in sequential decision making. Our results are thus compatible with the view that positive affect may have costs for older adults' decision making.

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Footnotes

1) Additionally, participants filled out the Satisficing and Maximizing questionnaire by Schwartz et al. (2002) and the Preference for Intuition and Deliberation (PID) questionnaire by Betsch (2004).

2) The results do not substantially change when considering all participants.

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Appendix A

Description of the Multiple Threshold Strategy and Computational Modeling

To better understand how participants solved the sequential choice task, we constructed a computational model to study participants' choices. In the original secretary problem, in which payoffs are only received when the best option is found, Seale and Rapoport (1997, 2000) showed that a single threshold model provides the best description of participant behavior. In secretary games with rank-dependent payoffs as in the task we use here an extension of the single threshold strategy which employs multiple thresholds is necessary to describe behavior (Bearden, et al., 2006; von Helversen, et al., 2011; Yeo & Yeo, 1994).

The multiple threshold strategy assumes that participants set thresholds that determine when they will accept an option with a given relative rank. Relative rank refers to the rank of an option compared with the options seen thus far. Accordingly if an option is better than all options seen thus far, it has a relative rank of 1, if it is better than all but one of the offers seen thus far it has a relative rank of 2 an so on. These thresholds exist for each relative rank, meaning that participants set a threshold for each relative rank that will halt search once an option that is respectively best, second-best, third-best and n^{th}-best of the options seen so far is encountered. For instance, if the threshold for an option with a relative rank of 1 is 5, from the sixth offer on the strategy will accept any offer that is better than the first five offers. Because the threshold for a relative rank of 2 is higher than the threshold for a relative rank of 1 and the threshold for a relative rank of 3 is higher than the threshold for a relative rank of 2 and so on, this strategy will accept worse options as fewer options are left to choose from. Figure A1 illustrates the thresholds of an optimal multiple threshold strategy that maximizes the average payoff in a task with 40 options and rank dependent payoff. A person relying on the optimal multiple threshold strategy would not chose any option before seeing option number 12, but from option number 12 on, the participant would accept any option with a relative rank of one (that is an option that is better than all options seen thus far). From option number 20 on, the person would accept any option with a relative rank of one or two; from option 26 on, any option with a relative rank of three or lower would be chosen, and so on. The optimal multiple threshold strategy results in an average performance of 37 points in our task which corresponds to selecting the 4th best option out of 40.

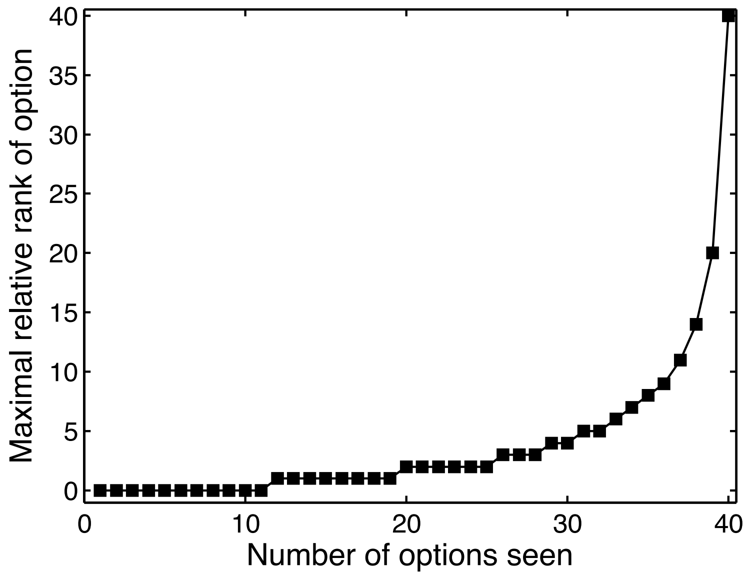

Figure A1. Shows the maximal relative rank an option may have to be accepted according to the optimal multiple threshold strategy at each point of the game.

The multiple threshold strategy has been found to describe human behavior well, although participants generally have lower thresholds than predicted by the optimal model (e.g., Bearden et al., 2006; von Helversen & Johnson, 2008). We assumed that participants' choices are in line with a multiple threshold strategy, but that the parameter values of the thresholds can differ between participants. To find the threshold values which best explained the participants' choices, we estimated the best fitting parameter values to the data of individual participants. We only estimated the best fitting values for thresholds for relative ranks of three or lower. We did not try to estimate further thresholds because in our task the majority of the choices, 88%, fell on an option with a relative rank of three or lower, and only 12% on options with a relative rank of four or higher. Thus, there was not enough data to obtain stable estimates for parameter values for thresholds for a relative rank of four or higher. Please note that the model with three thresholds encompasses simpler versions of the model with only one or two thresholds.

We found the best fitting threshold values for each participant by implementing a grid search in Matlab. More specifically, we calculated for each participant the number of choices that was predicted by any possible combination of threshold values, with each threshold taking a value between 0 and 40 (see Lewandowsky & Farell, 2010, for an overview on model fitting). We then chose the threshold values that maximized the number of choices predicted by the model. Additionally we implemented an error parameter to capture choices that deviated from model predictions because the participant rejected the first option that was predicted by the model. This error parameter may capture unintentional rejections for instance because a participant clicked too fast through the options. Alternatively, the error parameter can be interpreted as variance in choice, implying that thresholds are not deterministic but probabilistic in nature.

We also considered two baseline models: a random choice model and a simple search model, that assumes that participants always search through the same amount of options. A model assuming random choice predicts on average 4% of participants' choices. The simple search model was able to predict 12% of participants' choices. In comparison, the multiple threshold strategy with the estimated threshold values predicted participants' responses very well, explaining 68% (*SD* =11.06) of participants' choices and 78% (*SD* = 12.11) of choices of options with a relative rank of three or lower, suggesting it is a good model to describe participants' behavior. In addition, older and younger adults, where equally well fit by the model, M_{young} = 77.4, SD = 12.51, M_{old} = 78.39, SD = 11.88, t (60) = .32, p = .75. Average parameter values can be found in Table 1.

Appendix B

Correlations between behavioral measures in the sequential choice task and items measuring affect

Table B1 Correlations between Affect Items at Time 1 and Sequential Choice Measures in Study 1

	Search	Rank	Threshold 1	Threshold 2	Threshold 3
			Positive Affect		
PA scale	**-.40****	**.37****	**-.31***	**-.26***	**-.25***
Interested	**-.30***	**.37****	-.14	-.18	-.24
Excited	**-.26***	.19	**-.32***	-.24	-.19
Strong	-.09	.03	-.05	-.09	-.11
Enthusiastic	**-.35****	**.25***	**-.38****	-.23	-.14
Proud	-.16	.20	-.23	**-.27***	-.11
Alert	-.24	.14	-.06	-.01	-.23
Inspired	**-.30***	**.36****	-.21	-.17	-.07
Determined	**-.31***	**.27***	-.16	-.14	-.13
Attentive	**-.29***	**.28***	-.19	-.16	**-.26***
Active	**-.30***	**.36****	-.22	-.19	-.25
			Negative Affect		
NA scale	.13	-.06	.18	.07	.11
Distressed	.16	-.16	.22	.19	**.27***
Upset	.04	-.05	.09	.03	.16
Guilty	.11	-.06	.06	-.02	-.03
Scared	-.05	-.02	-.05	-.01	-.12
Hostile	.16	-.19	.11	.07	.08
Irritable	**.26***	-.21	**.27***	.13	.13
Ashamed	.09	-.01	.14	.07	.13
Nervous	.00	.18	.07	-.09	.01
Jittery	.12	-.02	.17	.06	.09
Afraid	.08	-.08	.17	.07	.04

Note: $N = 62$; PA = Positive affect; NA = Negative affect. Coefficients significantly different from zero at the .05 level are in boldface. * $p < .05$, ** $p < .01$

Table B2: Correlations between Affect Items at Time 2 and Sequential Choice Measures in Study 2

	Search	Rank	Threshold 1	Threshold 2	Threshold 3
			Positive Affect		
PA scale	-.12	.09	-.21	.03	.16
Interested	-.05	-.03	-.12	.04	.09
Excited	-.13	.07	**-.26***	.02	.06
Strong	-.03	.13	-.17	.07	.13
Enthusiastic	-.11	.06	**-.29****	.12	.10
Proud	-.12	.15	**-.31****	-.04	.04
Alert	-.06	.02	-.06	.03	.21
Inspired	-.17	.07	-.13	-.09	.08
Determined	-.08	.08	-.14	.01	.17
Attentive	.00	.04	.00	.06	**.22***
Active	-.05	.05	.00	.04	.10
			Negative Affect		
NA scale	-.12	.10	.08	**-.25***	-.18
Distressed	-.06	.07	.08	-.18	-.11
Upset	-.17	**.31****	.00	**-.31****	-.18
Guilty	.03	-.04	.10	-.12	-.04
Scared	-.14	.05	-.03	-.04	-.19
Hostile	-.09	.15	.02	-.11	-.21
Irritable	.01	.07	.13	-.13	-.10
Ashamed	-.03	.08	.05	-.12	-.14
Nervous	-.21	.08	-.01	**-.23***	-.08
Jittery	-.08	.00	.10	**-.26***	-.11
Afraid	-.09	-.01	.05	-.12	-.19

Note: $N = 81$; PA = Positive affect; NA = Negative affect. Coefficients significantly different from zero at the .05 level are in boldface. * $p < .05$, ** $p < .01$

Appendix C

Multilevel Modeling of Choice Satisfaction

To make use of the repeated-measurements of satisfaction and performance from the sequential decision task we used multilevel modeling. We conducted an initial screening of the amount of within-person variability in the satisfaction data using the intraclass correlation obtained from an unconditional means model in which the residual variance was significant. The analysis indicated that around one third of the total variance in satisfaction was located within persons (intraclass correlation = .31) and that group-mean reliability was good (.85). We also conducted analyses separately for the two age groups. The intraclass correlation was .27 and .36, and group-mean reliability was .81 and .86, for younger and older adults, respectively. We then used the following model to assess the link between choice satisfaction, performance, and positive affect (at time 1):

Level 1: $\text{Satisfaction}_{\text{it}} = \beta_{0it} + \beta_{1it}\,(\text{Performance}) + r_{it}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}\,(\text{Positive Affect}) + \gamma_{02}\,(\text{Age Group}) + u_{0i}$

$\beta_{1i} = \gamma_{10}$

In Level 1, choice satisfaction of participant *i* on block *t* is a function of the intercept (β_{0it}), performance obtained in that block (β_{1it}; rank 1 to 40), and the residual (r_{it}). In the Level 2 equations, γ_{00} represents the mean satisfaction for younger adults (when AGE = 0), γ_{01} represents the effect of positive affect on mean choice satisfaction, γ_{02} is the difference in average satisfaction between younger and older adults (when AGE = 1), γ_{10} captures the effect of performance on satisfaction, and u_{0i} and u_{1i} are residuals. We also tested additional models that considered whether the effect of affect varied as a function of age group or whether positive affect moderated the link between performance and satisfaction but these did not provide significantly better fits than the simpler model described above. We grand-mean centered positive affect and performance variables and estimated parameters for the model using R (version 2.11.1 (R Development Core Team, 2009), and the nlme package (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2009). As can be seen in Table C1, the parameter estimates suggest that 1) performance was significantly related to satisfaction, 2) younger and older adults did not differ significantly in choice satisfaction, and 3) positive affect was correlated with choice satisfaction. However, we also fitted similar models separately for the two age groups (i.e., excluding the effect of age group). As can be seen in Table C1, we found an effect of performance for both age groups, but only older adults showed a relation between positive affect and choice satisfaction, suggesting that only for older adults did positive affect significantly impact subjective evaluations of choice.

Table C1. Results from the Multilevel Regression Models

Effects	Coefficient	*SE*	*df*	*T*	*p*
			All Participants		
Intercept (γ_{00})	3.34	0.11	681	30.6	<.001
Performance (γ_{10})	-0.40	0.03	681	13.74	<.001
Positive Affect (γ_{01})	0.18	0.09	59	2.13	.04
Age Group (γ_{02})	-0.20	0.17	59	1.18	.25
			Younger Adults		
Intercept (γ_{00})	3.26	0.13	340	25.46	<.001
Performance (γ_{10})	-0.47	0.05	340	10.06	<.001
Positive Affect (γ_{01})	0.08	0.14	29	0.58	.57
			Older Adults		
Intercept (γ_{00})	3.09	0.11	340	27.08	<.001
Performance (γ_{10})	-0.34	0.04	340	9.60	<.001
Positive Affect (γ_{01})	0.24	0.11	29	2.27	.03

Table 1: Participant Characteristics, Decision Task Variables, and Threshold Parameters by Age Group in Study 1

	Younger Adults (n = 31)		Older Adults (n = 31)		Statistical Test		
Measures	*M*	*SD*	*M*	*SD*	*t(df)*	*p*	*d*
Participant Characteristics							
Vocabulary	29.83	4.57	34.00	2.75	4.21 (56)	.001	1.11
Processing Speed	66.17	14.75	46.66	11.82	5.56 (56)	.001	1.46
CRT	1.24	1.12	0.83	1.04	1.46 (56)	.15	0.38
Positive Affect 1	4.09	0.96	5.20	0.83	5.95 (60)	.001	1.24
Negative Affect 1	1.77	0.79	1.49	0.66	3.55 (60)	.001	0.38
Positive Affect 2	4.21	0.96	5.12	1.07	1.50 (60)	.14	0.90
Negative Affect 2	1.41	0.64	1.31	0.52	0.64 (60)	.53	0.17
Decision Task							
Performance	5.18	.90	6.61	1.87	3.83 (43.19)	.001	0.97
Search	18.61	4.20	15.90	6.09	2.04 (53.29)	.05	0.52
Goals	4.60	2.23	2.71	1.24	4.13 (46.95)	.001	1.05
Satisfaction	3.31	.57	3.16	.58	1.07 (60)	.29	0.26
Multiple Threshold Model							
Threshold 1	9.00	3.54	6.61	5.52	2.02 (60)	.05	0.52
Threshold 2	20.03	3.36	16.90	6.94	2.23 (43.34)	.03	0.57
Threshold 3	25.42	4.58	21.55	6.66	2.66 (60)	.01	0.68
Error	.42	.23	.69	.38	3.38 (60)	.001	0.86

Note: Sample size for vocabulary, processing speed and cognitive reflection was 29 for both younger adults and older adults because the data concerning these measures for 4 participants was lost. For performance, search, goals and threshold 2, we report corrected degrees of freedom for the t-test, because a Levene test indicated unequal variances.

Table 2: Correlations between sequential decision making variables, cognitive measures, and affect

	Speed	Cognitive Reflection	Vocabulary	Positive Affect	Negative Affect
Performance	**-.35**	-.25	.22	**.37**	-.06
Search	.05	-.06	-.02	**-.40**	.13
Threshold 1	.08	.02	.02	**-.31**	.18
Threshold 2	.05	.04	.04	**-.26**	.07
Threshold 3	.06	-.06	-.01	**-.25**	.11
Error	-.12	-.11	.08	**.26**	-.18

Note. Total sample size was 62 but sample size for the correlations involving cognitive ability measures (Speed, Cognitive Reflection, Vocabulary) is 58 due to lost data. Coefficients significantly different from zero at the .05 level are in boldface. Positive and negative affect refer to the measures taken before the sequential choice task.

Table 3: Correlations between sequential decision making variables, cognitive measures, and affect separately for younger and older adults

	Speed	Cognitive Reflection	Vocabulary	Positive Affect	Negative Affect
		Young Adults			
Performance	-.06	.02	-.04	.17	-.01
Search	.07	-.12	-.001	-.05	.20
Threshold 1	.12	.04	.08	-.003	**.37**
Threshold 2	-.08	.01	.27	.15	.12
Threshold 3	-.21	-.26	.06	-.03	.28
Error	.15	-.09	-.27	-.02	-.29
		Older Adults			
Performance	-.16	-.31	.04	.14	.05
Search	-.23	-.09	.23	**-.46**	-.01
Threshold 1	-.17	-.05	.21	-.31	-.03
Threshold 2	-.17	-.02	.19	-.22	-.14
Threshold 3	-.08	-.03	.28	-.09	.01
Error	.16	-.02	-.04	.05	-.06

Note. Sample size for the correlations involving cognitive ability measures (Speed, Cognitive Reflection, Vocabulary) is 29 for both younger and older adults due to lost data. Coefficients significantly different from zero at the .05 level are in boldface. Positive and negative affect refer to the measures taken before the sequential choice task.

Table 4: Mean (SD) Valence and Arousal Measures of the Selected Affective Stimuli

	Affect condition			
	Neutral		Positive	
Measures	Men	Women	Men	Women
Valence	5.16 (0.23)	5.09 (0.28)	7.27 (0.30)	7.95 (0.33)
Arousal	4.29 (0.48)	4.31 (0.47)	4.68 (0.50)	4.65 (0.50)

Table 5: Positive and Negative Affect in Study 2

	Affect condition	
	Neutral (N = 40)	Positive (N = 41)
	M (SD)	*M (SD)*
PA_1	4.25 (0.98)	4.34 (0.83)
PA_2	4.17 (1.02)	4.67 (0.96)
PA_3	3.87 (1.17)	4.36 (1.23)
NA_1	1.77 (0.56)	1.44 (0.54)
NA_2	1.61 (0.61)	1.24 (0.50)
NA_3	1.43 (0.48)	1.27 (0.50)

Note: PA_1/NA_1 denotes positive/negative affect before the affect manipulation, PA_2/NA_2 positive/negative affect after the affect manipulation and before the sequential choice task; PA_3/NA_3 positive/negative affect after the sequential choice task.

Table 6. Decision Task Variables by Affect Condition in Study 2

Measures	Affect condition		Statistical Test		
	Neutral	Positive	*t* (79)	*p*	*d*
	M (SD)	*M (SD)*			
		Decision Task			
Search	16.67 (4.91)	15.98 (3.76)	0.71	.48	0.15
Performance (rank)	5.62 (1.23)	5.61 (1.20)	0.03	.98	0.01
Performance Goals	4.39 (2.34)	4.65 (2.36)	0.51	.61	0.11
Satisfaction	3.33 (0.58)	3.21 (0.67)	0.89	.38	0.19
		Multiple Threshold Model			
Threshold 1	7.58 (3.51)	6.05 (2.28)	2.33	.02	0.52
Threshold 2	16.05 (5.62)	16.93 (5.35)	0.72	.47	0.16
Threshold 3	21.73 (4.80)	23.49 (5.36)	1.56	.12	0.35
Error	0.55 (0.21)	0.60 (0.25)	0.95	.34	0.22

Note: $N_{neutral} = 40$; $N_{positive} = 41$.

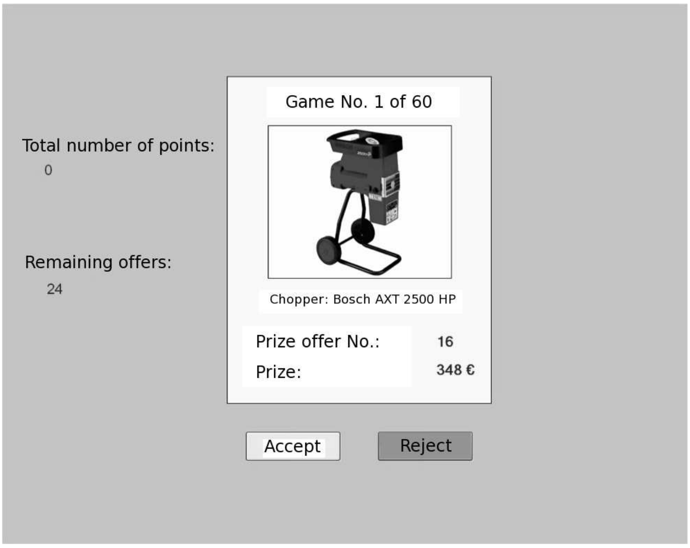

Figure 1. Screenshot of the shopping task.

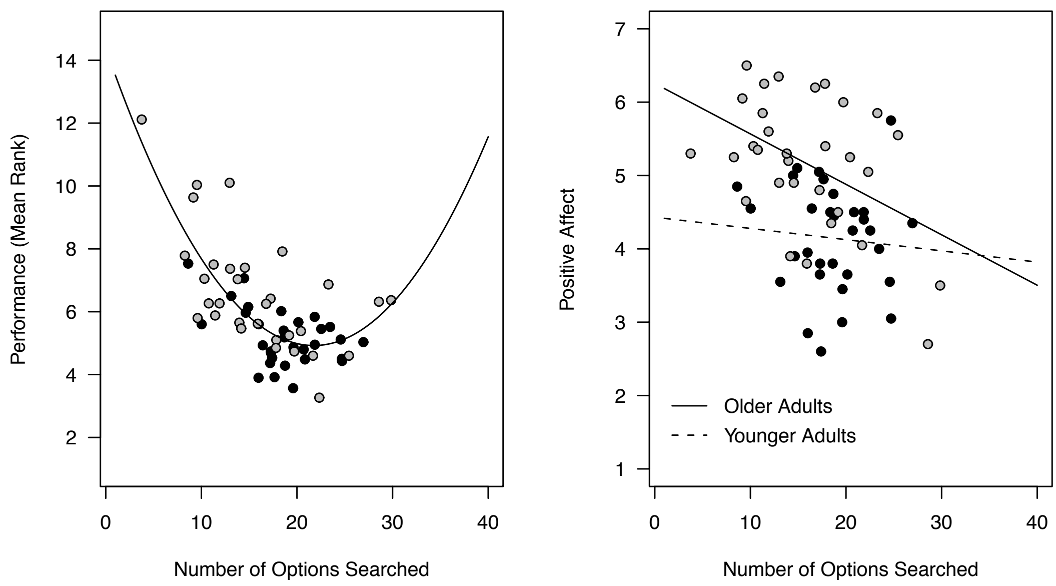

Figure 2. Search, performance, and positive affect. The left panel shows the curvilinear relation between search and performance (lower values indicate higher ranks) for younger and older adults; the right panel shows the linear relation between search and positive affect separately for younger and older adults. Markers denote age group: Younger adults, black; Older adults, grey.